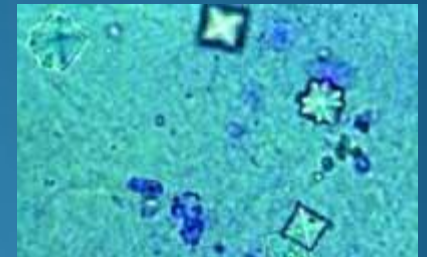


Renal Stone Risk During Spaceflight : Assessment and Countermeasure Validation (Renal_Stone)



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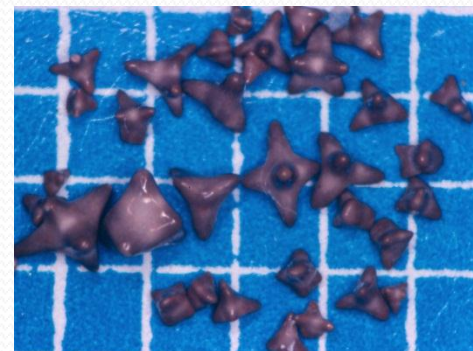
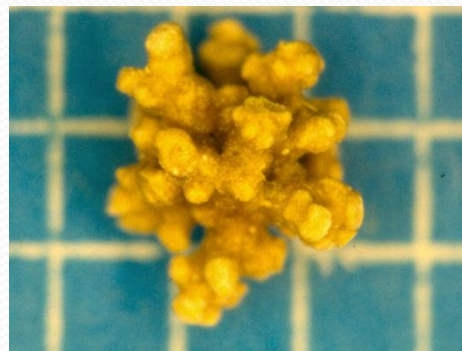


***Who were the principal
investigator(s)?***

**Peggy A. Whitson, Ph.D.,
Johnson Space Center,
Houston, TX**

What were they trying to learn through the experiment?

- To study the development of renal stones in space crews during and after space flight
- To learn the performance of Potassium Citrate (K-cit) as a countermeasure to reduce the risk of renal stone formation in space (On Earth, Potassium Citrate therapy has been proven to lessen the development of renal stone containing calcium)





***Which mission(s) was the
experiment flown on?***

**Expedition Three, ISS Mission
7A.1, STS-105 Space Shuttle
Flight**

What are the Earth and Space applications gained from this experiment?

1) Applications in Space:

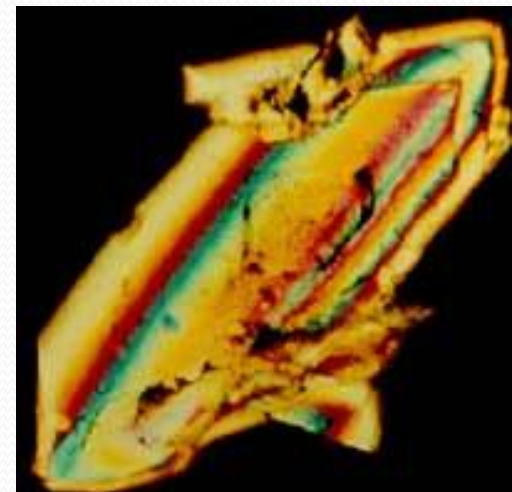
In microgravity environment, many physiological changes can occur in humans during or after flight. Some of these are alterations in renal function, bone loss, fluid redistribution, and muscle atrophy. These are responsible for major changes in urinary system and formation of renal stone. In-flight changes previously observed include decreased urine volume and urinary citrate and increased urinary concentrations of calcium and sodium. Renal stone formation in crewmembers can have adverse affects on their health which in turn will impact the success of the mission. This experiment was intended to study the risk factors of renal stone formation during and after flight and also the use of potassium citrate as a countermeasure to reduce the risk.

What are the Earth and Space applications gained from this experiment?

2) Applications on Earth:

Studying how the renal stone develops in otherwise healthy crewmembers under changing environmental conditions can enrich the knowledge about stone formation on Earth.

Micrograph of Calcium Carbonate crystal found in a kidney stone. Calcium-containing stones are the most common type of kidney stones that form in humans.



What were the procedures or steps of the experiment?

Materials and Equipments used:

- 1. Pallet containing the pills (Either Potassium Citrate or Placebos)**
- 2. Inventory Management System Barcode Reader**
- 3. Urine Collection Kits (UCK) -- Pouch made of Nomex (fabric resistant to fire and puncture)**
- 4. Male or Female Adapters**
- 5. Ziplock bags**
- 6. Wet and dry wipes**
- 7. Syringe Sample tubes and Syringe Adapters**

What were the procedures or steps of the experiment?

Step 1: Collection of Data

The Renal Stone experiment used two sequential sampling groups in single-trial, two-phase design.

- ❖ Phase 1 sampled 12 male astronauts during NASA-Mir spaceflights during 129 to 208-day missions and served as a control group with no treatment.
- ❖ Phase 2 collected data from 18 ISS crewmembers in a “double-blind” study. Each crew member was given a pallet containing the pills and Urine Collection Kits. The crew members used the Inventory Management System Barcode Reader to record the samples, food intake (food packets are marked with barcodes), and medication.
 - Two pills were taken during dinner, but crew member was not aware whether it was Potassium Citrate or Placebos. From 3 days before launch and up to 14 days after landing each crewmember ingested either two K-cit tablets or two placebos daily.
 - Samples of urine were collected during 24-hour periods at 3 points during the mission, at the beginning, midway, and at the end. Urine samples were collected using the syringe sample tubes and syringe adapters . The syringe adapters served as interface to connect a sample syringe with Urine Collection Devices for removal of sample.

What were the procedures or steps of the experiment?

Step 2: Analysis by Principal Investigator

- Next, the samples were sent to Earth for chemical analysis. The Principal Investigator (PI) studied the urine chemistry of the crew members to determine the risk of renal stone development in each individual.
- The results were further compared based on the crew member's medication and daily activities to identify what may have caused alterations in stone-forming chemicals.
- The experiment involved measuring the entire volume of urine from each crew member and the chemical amounts in stones formed from calcium, oxalate, sodium, sulfate, phosphorus, magnesium, potassium, creatinine, uric acid, and also the pH level.

What were the procedures or steps of the experiment?

Renal Stone Urine Collection Kits containing the Urine Collection Devices, Urine Collection Bags and Syringes at Johnson Space Center.



- ❖ ESA astronauts attending Renal Stone training at Johnson Space Center.
- ❖ Renal Stone hardware containing potassium citrate/placebo pallets and urine collection kit.



What were the procedures or steps of the experiment?

Renal Stone hardware on board ISS during Increment 11

ISS Expedition 11 Science Officer John Phillips with Renal Stone Hardware on board ISS.



What were the procedures or steps of the experiment?

ISS Commander Sergei Krikalev with Renal Stone Hardware during ISS Expedition 11.



ISS Expedition 13 Flight Engineer, Thomas Reiter, on board ISS processes samples for the Renal Stone investigation.



What were the results?

- ❖ Crew members are at higher risk of developing calcium oxalate, calcium phosphate and uric acid stones during space missions because crew's urine is highly saturated with chemicals like the stone-forming salts due to decreased urine output and pH and also increased excretion of calcium.
- ❖ Renal Stone study concludes the effectiveness of Potassium Citrate or K-cit in minimizing renal stone formation during and after space missions. Astronauts who ingested K-cit had significant decrease in CAOX and uric-acid.
- ❖ K-Cit also increases urinary pH without raising the risk for forming brushite stones, and proved to be well tolerated in the entire course of the experiment.
- ❖ Medical therapy options, largely accessible on Earth, are limited during space exploration. Hence "Prevention is Better than Cure" is the best approach.
- ❖ The Renal Stone experiment emphasizes the importance of balancing between pharmacological safety and effectiveness in carrying out medical research in which astronauts are involved while collecting the data.

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